

Appln No. : 10/054,051  
Applicant : Epstein, *et al*  
Filed : January 22, 2002  
TC/A.U. : 2121  
Examiner : Hiri, Joseph P.

Confirmation No. 1351

Docket No. : BOC9-2000-0039 (180)

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**DECLARATION UNDER 37 C.F.R. § 1.131**

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Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22203-1450

Sir:

I, Mark E. Epstein, a citizen of the United States of America, residing at 14 Old Village Lane, Katonah, NY 10536, hereby declare and state as follows:

1. I was employed by International Business Machines Corporation (IBM) of Yorktown Heights, New York at the time the above-identified application was conceived and I continue to be employed by IBM. I make this declaration in support the above-identified application.

2. IBM has invested substantial time and effort into the research, development, and marketing of their products, and in an effort to protect its rights in all new inventions, IBM requests that all employees prepare and submit IBM Confidential Invention Disclosure Forms upon conception by the inventor(s).

3. As a named co-inventor for this invention, I submitted the attached IBM Confidential Invention Disclosure BOC8-2000-0029.

4. I make this Declaration to establish that I and my co-inventor Jerome L. Quinn conceived of the present invention at least as early as April 13, 2000, and exercised due diligence from prior to April 13, 2000 to January 22, 2002, the filing date for the above-identified patent application.

{WP184699.1}

5. I further declare that all statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code, and that such willful, false statements may jeopardize the validity of the above-identified patent application or any patent issuing thereon

Mark E. Epstein  
Mark E. Epstein

Date: 6/22/04

STATE OF NEW YORK )

COUNTY OF WESTCHESTER )

) ss:

The foregoing instrument was sworn to and subscribed before me this 22<sup>nd</sup> day of June, 2004, by MARK E. EPSTEIN, who is personally known to me or who has produced driver's license (type of identification) as identification.

Robin Louise Moru  
NOTARY PUBLIC,  
STATE OF NEW YORK

(Print, Type or Stamp Commissioned Name of Notary Public)

Robin Louise Moru  
Notary Public, State of NY  
No. 01D16045019  
County of Westchester  
Commission Expires July 17, 2006



## Disclosure BOC8-2000-0029

Created By: Mark E Epstein Created On: 04/01/2000 09:34:44 AM  
 Last Modified By: wpts1 wpts1 Last Modified On: 04/13/2000 09:13:29 PM

\*\*\* IBM Confidential \*\*\*

Required fields are marked with the asterisk (\*) and must be filled in to complete the form.

### Summary

Status	Under Evaluation
Processing Location	BOC
Functional Area	Speech Development & Customization (O. Osborne)
Attorney/Patent Professional	Richard Tomlin/Boca Raton/IBM
IDT Team	David Reich/West Palm Beach/IBM
Submitted Date	04/01/2000 11:14:49 AM
Owning Division	SWG
	41
Incentive Program	
Lab	
Technology Code	

### Inventors with Lotus Notes IDs

Inventors: Mark E Epstein/Watson/IBM

Inventor Name > denotes primary contact	Inventor Serial	Div/Dept	Manager Serial	Manager Name
> Epstein, Mark E.	001914	7G/OLBA	048379	Epstein, Edward A.

### Inventors without Lotus Notes IDs

#### IDT Selection

IDT Team: David Reich/West Palm Beach/IBM	Attorney/Patent Professional: Richard Tomlin/Boca Raton/IBM
--	--

Response Due to IP&L : 05/13/2000

### Main Idea

#### \*Title of disclosure (In English)

A Fast Way of Tuning Decision Tree Models

#### \*Idea of disclosure

1. Describe your invention, stating the problem solved (if appropriate), and indicating the advantages of using the invention.

Invention: The invention has 4 parts:

- Determine the potential usefulness of a new decision tree question without requiring the complete tree to be regrown.
- Determine where in a decision tree the correct answer would be found, and show where the tree went away for a particular error.
- The GUI elements for viewing and debugging a decision tree.

JUL 26 2000

## A Fast Way of Tuning Decision Tree Models - continued

- The ability to regrow only parts of a decision tree.

Problem solved: Tuning decision tree models takes significant amount of time for an experienced developer. In the current VVT NLU 1.2 toolkit, the application developer tunes a decision tree by iteratively applying the following process:

- 1) Run a regression test on some training data with the current model.
- 2) Find a sentence that has an incorrect parse tree as output.
- 3) Locate where in the sentence the incorrect parse deviated from the truth.
- 4) Examine the training data to discover a feature that is different in the parse trees similar to the correct parse and similar to the incorrect parse.
- 5) Add a decision tree question which utilizes this feature.
- 6) Retrain the decision tree models.
- 7) Rerun the regression test.

For the current VVT NLU toolkit, it can take 3-7 minutes to collect the decision tree data, grow the trees, and smooth the trees. It then can take another 1-2 minutes to run the regression test. Thus, after the user spends possibly 1-15 minutes discovering the feature (steps 2-4), he usually has to spend 5-10 minutes waiting to test the result (steps 5-7). This invention proposes a way to let a user know much faster whether or not it is even possible that a question will have utility. Thus, if the question shows no value, there is no reason to add it to the pool of questions and iterate. The invention also proposes GUI elements that can help the user evaluate the utility of the question before having to iterate.

Advantages: The obvious advantage is that it will tremendously speed the development of applications using decision trees. There are 2 other advantages as well. First, it takes an experienced application developer to be able to use intuition to discover a good question to add. A novice user would waste lots of time adding bad questions and iterating. With this invention, many "bad questions" will not even be tried by the user. Second, this technique opens the door for an automatic tuning system (eg an expert system), which can automatically suggest questions, evaluate them, and test them. This would not be feasible if each question took 10 minutes to evaluate. But with this invention, only the most promising questions need to be examined, and these can be added in bulk (making use of the decision tree algorithms capability of "ignoring" useless questions). Thus with this invention, it is much more likely to make a self-tuning system.

2. How does the invention solve the problem or achieve an advantage, (a description of "the invention", including figures inline as appropriate)?

- Determine the potential usefulness of a new decision tree question without requiring the complete tree to be regrown:

This is done using the following techniques:

- Once the user proposes the new decision tree question, we can examine the existing decision tree to determine the path the incorrect answer took. Along this path, we know each question asked, and the conditional entropy drop attained by asking the OLD question at that node. At each node, we can evaluate the data at that node with the NEW question. If the conditional entropy drop by the NEW question is less, then we know that this question WOULD have been asked had it been available at the time the decision tree was built. It is possible the question could have been asked elsewhere, possibly having results in other sentences. But for this current error, the question does provide value. The real win comes in that often a question that seems to be valuable, provides no value for a specific problem. There are other questions which provide more information. Thus, the real win is when the question provides no value and does NOT provide a greater conditional entropy reduction than all the old questions. Also, generally the "higher" up in the decision tree a question is asked, the more important it is. Thus, the user gets feedback as to whether this is a really important question or one of lesser importance by how early in the tree this question would have been applied.
- Once one has confirmed that a question could provide value for this specific error, one can

## A Fast Way of Tuning Decision Tree Models - continued

examine its broader use by directly examining the complete set of sentences that illustrate the correct answer and the set of sentences that illustrate the incorrect answer. This is slightly different than the previous bullet in that some of these sentences might have been split off into a different part of the tree. The most significant a separation a question provides, the better. This helps one to select a better question if many pass the test provided by the first bullet.

Once the best question has been found, the complete tree can then be regrown, with greater confidence in knowing that it will be used to help solve the problem for which it is being added.

- Determine where in a decision tree the correct answer would be found, and show where the tree went awry for a particular error.

Sometimes when a decision tree system makes an error, it is not because of a missing question, but rather undertraining (which happens because of the data fragmentation done by the decision tree algorithm) or a bad question. This invention proposes a solution to this as follows:

- One can look at all leaves of the decision tree to search for the leaves that provide the "correct" answer. The correct answer is one in which the desired outcome has the greatest probability. These are the desired "target" leaves.
- One can then find the leaf that the incorrect answer reached.
- Then one can climb all these leaves upwards, looking for intersections where the leaves have common ancestors. The goal is to discover all nodes where the incorrect branch was taken. This finds that. By examining the entropy and probabilities of the correct child for each of these nodes, we can discover the more important nodes to focus on. The system can then let the user know which question was applied at that node, what the counts were, and even the sentences at the parent and 2 children.
- The GUI elements for viewing and debugging a decision tree. Critical to a successful implementation of these algorithms is how the information is presented to the user. This invention proposes the following GUI look and feel:
  - A split screen display. One of the screens is the shape view, which shows the shape of the decision tree, along with the count of the number of events at each node.
  - In this view, the tree will be shown in one color, but the path taken from the root to incorrect leaf will be shown in red.
  - The correct leaves will be shown in green.
  - The common red ancestor nodes to green leaves will be shown with a different shape. Instantly, the user will be able to see a useful overview of where the correct parse needed to be, and where the incorrect parse ended.
  - The second window provides a more detailed zoom view of a single parent and its two children of the decision tree. This node in focus will be shown by drawing a box or circle around it in the shape view.
  - The detailed zoom window will show the entropy and histogram of the distributions for the parent and its children.
  - It can also show the smoothing lambdas.
  - By clicking appropriately, one can invoke a search for all sentences that contain data at that node.
  - By clicking appropriately, one can examine the question that is being applied at this node... its syntax, parameters, bitstrings, etc. One can also ask to examine where else in this or other decision trees this question is used.
  - One can also change the focus node by a specific click or keyboard shortcut. Thus one does not have to go back to the shape window to do this.

Eventually, this can be enhanced to provide a hint subwindow, which could search for questions that might be useful to drive the tree to learn the correct parse for this sentence.

- The ability to regrow only parts of a decision tree:

## A Fast Way of Tuning Decision Tree Models - continued

Once the user decides to add a question, it is not necessary to regrow the whole tree from scratch, though this is what is typically done. It is sufficient to adapt the current tree. One can apply this question at the root, and recursively down through its children. If ever this question provides a larger reduction in conditional entropy, then one can then apply this question at that node instead. Then, the complete subtree underneath this node will have to be regrown. But in general, a new question added to a model that is already functioning at 70-80%, will not be at the root or even 2nd level of the tree. Thus, if this question is only asked at one of the 4 grandchildren of the root, only 25% of the tree will have to be regrown. This can be a significant time savings. While researchers never worry about implementation details like this, the savings can add up when you're working to deploy a solution quickly for a customer on a tight schedule.

3. If the same advantage or problem has been identified by others (inside/outside IBM), how have those others solved it and does your solution differ and why is it better?

4. If the invention is implemented in a product or prototype, include technical details, purpose, disclosure details to others and the date of that implementation.

## \*Critical Questions ( Questions 1 - 7 must be answered)

## \*Question 1

On what date was the invention workable? 03/10/2000. Please format the date as MM/DD/YYYY (Workable means i.e. when you know that your design will solve the problem)

## \*Question 2

Is there any planned or actual publication or disclosure of your invention to anyone outside IBM? ☐ Yes ☒ No

If yes, Enter the name of each publication or patent and the date published below.

Publication/Patent:

Date Published or Issued:

Are you aware of any publications, products or patents that relate to this invention? ☐ Yes ☒ No

If yes, Enter the name of each publication or patent and the date published below.

Publication/Patent:

Date Published or Issued:

## \*Question 3

Has the subject matter of the invention or a product incorporating the invention been sold, used internally in manufacturing, announced for sale, or included in a proposal? ☐ Yes ☒ No

Is a sale, use in manufacturing, product announcement, or proposal planned? ☐ Yes ☒ No

If Yes, identify the product if known and indicate the date or planned date of sale, announcements, or proposal and to whom the sale, announcement or proposal has been or will be made.

Product:

Version/Release:

Code Name:

Date:

To Whom:

If more than one, use cut and paste and append as necessary in the field provided.

## \*Question 4

Was the subject matter of your invention or a product incorporating your invention used in public, e.g., outside IBM or in the presence of non-IBMs? ☐ Yes ☒ No

If yes, give a date. Please format the date as MM/DD/YYYY

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## A Fast Way of Tuning Decision Tree Models - continued

<b>*Question 5</b> Have you ever discussed your invention with others not employed at IBM?	<input type="radio"/> Yes <input checked="" type="radio"/> No
If yes, identify individuals and date discussed. Fill in the text area with the following information, the names of the individuals, the employer, date discussed, under CDA, and CDA #.	

<b>*Question 6</b> Was the invention, in any way, started or developed under a government contract or project?	<input type="radio"/> Yes <input checked="" type="radio"/> No <input type="radio"/> Not sure
If Yes, enter the contract number	

<b>*Question 7</b> Was the invention made in the course of any alliance, joint development or other contract activities?	<input type="radio"/> Yes <input checked="" type="radio"/> No <input type="radio"/> Not Sure
If Yes, enter the following :Name of Alliance, Contractor or Joint Developer	
Contract ID number	
Relationship contact name	
Relationship contact E-mail	
Relationship contact phone	

<b>Question 8</b> Have you submitted, or are you aware of, any related disclosure submission?	<input checked="" type="radio"/> Yes <input type="radio"/> No
If Yes, please provide the title and docket or disclosure number below:	
An Interactive Development Environment for Building High Quality Conversational Natural Language Applications	

<b>Question 9</b> What type of companies do you expect to compete with inventions of this type? Check all that apply.
<input type="checkbox"/> Manufacturers of enterprise servers <input type="checkbox"/> Manufacturers of entry servers <input type="checkbox"/> Manufacturers of workstations <input type="checkbox"/> Manufacturers of PC's <input type="checkbox"/> Non-computer manufacturers <input type="checkbox"/> Developers of operating systems <input type="checkbox"/> Developers of networking software <input checked="" type="checkbox"/> Developers of application software <input checked="" type="checkbox"/> Integrated solution providers <input type="checkbox"/> Service providers <input type="checkbox"/> Other (Please specify below)

**Patent Value Tool (Optional - this may be used by the inventor and attorney to assist with the evaluation)**

(The Patent Value tool can be used by you or the evaluation team to determine the potential licensing value of your invention.)

These are the answers which were entered into the Patent Value Tool.

**Market**

What is the anticipated annual market size (in dollars) that will be captured by your invention?

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**A Fast Way of Tuning Decision Tree Models - continued**

\$100M to \$1B

Reason(s) for above Answer Decision Trees are used in many applications. This speeds development of decision tree models.

**CLAIMS**

**Question 1** - How new is the technical field?

Emerging

Reason(s) for above Answer While decision trees have been around for more than 20 years, they are just starting to get deployed in NLU systems.

**Question 2** - How central is the invention to the product(s) which might be expected to contain the invention?

Main

Reason(s) for above Answer This is not necessary to use decision trees... it will just speed development.

**Question 3** - What is the scope of the claim?

Fundamental

Reason(s) for above Answer This idea will work in any decision tree application

**PORTFOLIO NEED**

What are the portfolio needs in the area of your invention?  
Listed in PPM Needs

**EXPLOITATION & ENFORCEMENT**

**Question 1** - How easily can the use of the invention by a competitor be detected?

Trivially

Reason(s) for above Answer Since this invention proposes not only algorithms, but a look and feel interface, this can easily be spotted.

**Question 2** - How easily can the use of the invention be avoided by a competitor?

With much work

Reason(s) for above Answer Other techniques could be used, like completely regrowing the tree each time a question is added. It just puts the burden on the user. Thus, while it can easily be avoided, doing so significantly impedes the competitors ability to develop a timely solution for a customer.

**BUSINESS VALUE**

**Question 1** - What percentage of the companies producing products in the field of this invention might use this invention?

By 10% to 30%

**Question 2** - What is the value of this patent to current or anticipated Alliance Activity between IBM and other companies?

High value

**Question 3** - What is the value of this patent to current or anticipated Technology Transfer Activity between IBM and other companies?

High value

**Question 4** - Does it result in prestige to IBM?

Industry wide

Reason(s) for above Answer This will help people in Computational Linguistics realize that decision trees are easy to use and tune. Even those experienced will appreciate the contributions.

**Post Disclosure Text & Drawings**

(Form Revised 12/17/97)



International Business Machines Corporation

P.O. Box 1328  
Boca Raton, Florida 33429-1328  
407/443-2200

July 21, 2000

Quarles & Brady  
222 Lakeview Avenue  
Fourth Floor  
Post Office 3188  
West Palm Beach, FL 33402-3188

REF: Invention Disclosure: BOC8-2000-0029  
Title: A FAST WAY OF TUNING DECISION TREE MODEL  
IBM Docket: BOC9-2000-0039

Dear Steve,

Please prepare and file the above referenced cases with the U. S. Patent and Trademark Office. A copy of the invention disclosure is enclosed for your use in preparing the applications in accordance with IBM's format.

Sincerely,

*Richard A. Tomlin*

Richard A. Tomlin  
Consulting Attorney

Enclosure

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76 2000

JUN-30-04 15:54

FROM-AKerman SENTERFITT

5616596313

T-126 P.24/31 F-893

# AKERMAN SENTERFITT

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WEST PALM BEACH, FLORIDA 33401  
PHONE (561) 653-5000 • FAX (561) 653-5333  
<http://www.akerman.com>

April 4, 2001

VIA FACSIMILE 914-945-4490  
Mr. Mark E. Epstein  
IBM Corporation  
T.J. Watson Research Center  
Route 134  
Kitchawan Road  
Yorktown Heights, NY 10598

Re: New Patent Application  
METHOD OF TUNING A DECISION TREE MODEL  
IBM Docket: BOC9-2000-0039; Our Ref: 6169-180

Dear Mark:

Enclosed please find a draft of a patent application for the above-identified matter. Please review it carefully to ensure that the description of the invention accurately recites all of the invention's characteristics in the broadest possible manner, while also explaining in detail, the preferred embodiment of the invention. The drawings should also be reviewed to confirm that they accurately depict the various details of the invention as you understand them. Finally, please read through the numbered claims at the end of the application. The claims will define the scope of protection any patent issuing from this application will provide. Accordingly, you should review them to ensure that they do not unduly restrict the scope of the invention by including any unnecessary detail. After you have reviewed the application, please call me with any comments you may have.

Please recall that patent applicants have a duty to disclose to the United States Patent Office all reasonably pertinent prior art of which they are aware. Failure to do so can jeopardize the validity of any patent issuing from an application. Accordingly, should you become aware of such references at any time during the pendency of this application, please let us know.

Very truly yours,

AKERMAN SENTERFITT

*Kevin T. Cuenot*

Kevin T. Cuenot

KTC/kmw  
Enclosures

P1010378.1

AKERMAN SENTERFITT & EIDSON, P.A.

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\*\* TX STATUS REPORT \*\*

AS OF MAY 04 2001 09:55 PAGE.01

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<b>PLEASE DELIVER THE ACCOMPANYING TELECOPIED MATERIAL TO:</b>	<b>TRANSMITTAL DATE:</b> May 4, 2001
<b>NAME:</b> Mark Epstein	<b>CLIENT/MATTER NO:</b> 6169-180
<b>PHONE:</b>	<b>TOTAL PAGES:</b> 23
<b>FIRM/COMPANY NAME:</b>	<b>CITY, STATE:</b>

**SENDER'S NAME:** Kevin T. Cuenot

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AS OF AUG 16 2001 11:48 PAGE.01

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Attached is the revised application and the drawings. The drawings couldn't be sent electronically.

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October 15, 2001

Mr. Mark E. Epstein  
IBM Corporation  
T.J. Watson Research Center  
Route 134  
Kitchawan Road  
Yorktown Heights, NY 10598

Re: New Patent Application  
METHOD OF TUNING A DECISION NETWORK AND A DECISION TREE  
MODEL  
IBM Docket No. BOC9-2000-0039; Our Ref: 6169-180

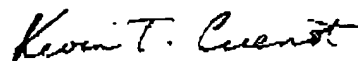
Dear Mark:

Enclosed please find a final draft of the above-identified patent application together with the Declaration and Power of Attorney, Assignment, and Oath and Assignment for the Republic of China. If the application is acceptable, please sign and date the enclosed documents where indicated and instruct the other inventors to do the same. Please note that pursuant to IBM's request, all of the signatures must be contained on the same page(s). In addition, pursuant to IBM's request, we must receive the originally executed Oath and Assignment for the Republic of China. Once the documents are fully executed, please fax the documents to me at 561-653-5333 along with mailing the originals to the address listed above.

Please feel free to contact me if you should have any questions or comments.

Very truly yours,

AKERMANN SENTERFITT



Kevin T. Cuenot

KTC/aa  
Enclosures

JUN-30-04 15:55

FROM-AKERMAN SENTERFITT

5616596313

T-126 P.28/31 F-893

March 22, 2001

pg. 3 of 4

✓ 0169-180 Status of Prep<sup>d</sup> Filing Patent  
awaiting Invention Review 9/11/04  
10/1 month

May 6, 2001

✓ 1669-180 Status of Prep 3 Filing Appen. 800/8mg  
Awaiting ~~Response~~ Resp. 10/month

JUN-30-04 15:56

FROM-AKERMANN SENTERFITT

5616596313

T-126 P.30/31 F-893

P 3 of 7

June 6, 2001

6169-180 Status of Prep. & Filing Appl. GAN/SMK  
In Process (KTC) - Awaiting investor review 07/06/01



Wednesday, June 30, 2004

Page: 1

**Actions Due**

ocket Number: 06169-0180

Country: US United States of America

Status: Published

Action Type: Status Of Filing New Appln.

Application #: 10/054051

SubCase: 0

Case Type: PRI

Filing Date: 22-Jan-2002

Base Date: 08-Sep-2001

Response sent date:

Action(s) Due	Due Date	Indicator	Taken
Status Of Filing New Appln.	08-Sep-2001	Final	04-Sep-2001
Status Of Filing New Appln.	08-Oct-2001	Reminder	03-Oct-2001
Status Of Filing New Appln.	27-Nov-2001	Reminder	26-Nov-2001

**Remarks:**

09/04/01: Waiting on inventor's comments, r/o 1 month 10/3/01: r/o To 11/27/01  
11/26/01: will not file until 1/2/02

User ID: ZKEBEDE

Date Created: 12-Aug-2001

Last Update: 27-Nov-2001